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New distribution records of the alien plant – *Sicyos angulatus* L. (Cucurbitaceae) from Georgia

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Abstract

The invasion of alien plants into the territory of Georgia started in ancient times and continues today. *Sicyos angulatus* L., a species of North American origin, is an example of such an invasion. The first established populations of *S. angulatus* occurrence in Georgia were observed in 2012. Since then, new localities have been recorded, both in agricultural and disturbed natural communities. The species, which has easily adapted to local soil and climatic conditions, is expanding every year and is already widely spread in west Georgia. The plant is characterized by fast and intense growth and a climbing habit using other plants as a support. In this contribution, the peculiarities of its distribution in Georgia and the morphological features and life-history characteristics of Georgian populations are provided.

Key words

Alien plant; Invasive species; Chorokhi Delta; Kolkheti Lowland.

Introduction

The genus *Sicyos* L. is the most diverse genus in the Cucurbitaceae family. It was proposed by Linnaeus (1753) as a genus with three species. Later, 31 species were recognized by Cogniaux (1881). The successor authors classified the genus as follows: family Cucurbitaceae, subfamily Cucurbitoideae, tribe Sicyeae, subtribe Sicyinae (other subtribes are Sicyosperma, Parasicyos, Microsechium, Sechium, Sechiolsis and Pterosicyos) and included 40 species (Jeffrey 1990; Rodríguez-Arévalo 2003). According to recent data, the genus *Sicyos* includes 64 species mainly distributed in the southeastern part of North America, the northern part of South America, and the southern and southeastern parts of Australia (POWO 2022). The genus includes mostly climbing annual herbaceous plants. According to the Flora of America, one of the species, *Sicyos angulatus* L., (bur cucumber), is characterized as a weed species, and included in the five most noxious weeds, which are difficult to control with many "standard" weed control programs (Stešević and Jovovic 2005).

The natural distribution of *Sicyos angulatus* is the eastern part of North America (Britton and Brown 1913; Nesom 2011). It was introduced to Europe in the 19th century as an ornamental plant (Bailey 1935; Hanson and Mason 1985; Steševi and Jovovi 2005) and the first record of *S. angulatus* in the wild was reported by Hayek (1927) from the Balkan Peninsula. The species is naturalized in moist places in central, southern, and southeastern Europe: Austria, the Czech Republic, Hungary, Italy, Romania, and the central and western parts of Russia (Tutin 1968). Since the second half of the twentieth century, the species has spread widely in Sweden, Croatia, Norway, France, the United Kingdom, Spain, Germany, Korea, Siberia, Japan, Slovenia, the Czech Republic, China, Australia, and the Caribbean islands (Dubravec and Trinajstić 1975; Hanson and Mason 1985; Ouren 1987; Clement et al. 1994; Hulina 1996; Shimizu 1999; Smeda and Weller 2001; Pyšek et al. 2002; Larché 2004; Tzonev 2005; Kim 2017; Zhao et al. 2019). It was found in Turkey (Duman and Güner 1996; Terzioğlu and Anşin 1999; Yazlık et al. 2018; Uysal and Boz 2018), Ukraine (EPPO 2010) and India (Thakur 2016).

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Figure 1. *Sicyos angulatus* climbing all over the Alnus barbata trees in disturbed areas of the Chorokhi Delta. (Photo by I. Mikeladze).

According to Vasilchenko (1975) *Sicyos angulatus* was distributed in the European part of the USSR, namely the middle and upper parts of the Dnieper River basin and the Volga-Don Canal. According to the same source, Ledebour (1844) indicates the genus for the Caucasus, but later the fact was not confirmed. The first specimens of *S. angulatus* were found in Georgia in 2012 on agricultural areas in the valley of the Chorokhi River (41°31.710'N, 41°42.820'E; 41°30.262'N, 41°42.690'E; 41°33.934' N, 41°39.688' E) reported by Mikeladze et al. (2015). Later, new localities were found both in agricultural lands and in semi-natural communities. Thus, *Sicyos* is a recent addition to the Georgian flora and the aim of the presented contribution was to study the distribution characteristics of this alien species in west Georgia.

Materials and methods

The materials were collected during the conventional route survey, which included plant description, photography, plant sampling, laboratory processing, herbarium preparation, and curation throughout the known and plausible areas of the species' distribution. In particular, river valleys, roadsides, agricultural lands, landfills, and wetlands were investigated during the irregular field trips in the period of 2012-2022.

Results and discussion

Sicyos angulatus L., Sp. pl. 1013 (1753), is an annual herbaceous vine, 4-10 m long, completely fading in the coldest months of the year. Stem angular, pubescent, with 3–4 diverged tendrils. The maximum length of the plant (stem) recorded in Georgia is 16 m.

Leaves are simple, palmately veined, 5-lobed, alternately arranged, up to 25 cm across and borne on stout, pubescent petioles 2.5 to 10 cm long. The plant stem and the underside of a leaf along the petiole are pubescent. The petiole is generally 5 cm long. The root system consists of a shallow branched taproot (Fig. 1).

Sicyos angulatus climbs with axillary tendrils bearing three or four branches. Branches of a tendril originate 2-5 cm above the base of the tendril. When the tip of the tendril makes contact with a support, it wraps or hooks around it, securing the tendril. Proximally to the contact point, the tendril then begins to twist, forming spirals. It has an unusual ability, known as perversion to form spirals, first in one direction and then further in the other.

Flowers are monoecious, with both staminate and pistillate flowers generally arising from the same axis on pubescent peduncles. The peduncles of the pistillate flowers are generally the same length as the pedicels, whereas the peduncles of the staminate flowers are several times longer than the pedicels. Calyx is green, five-toothed, pubescent. Corolla is white, green-striate, consists of five petals fused at the base into an open bowl, free and spread at the tips. Staminate flowers form on paniculate or racemose inflorescences. The anthers unite to form a central column. Pistillate flowers are borne on a compact cyme, in a globose cluster of 8-20 flowers. The pistil consists of a superior ovary, a slender style, and 3 stigmas (Terzioglu and Ansin 1999; Tzonev 2005; Mikeladze et al. 2015). The flowering period in Georgia is from mid-July to September/mid-October. Flowers are insect- (bees, flies), or self-pollinated.

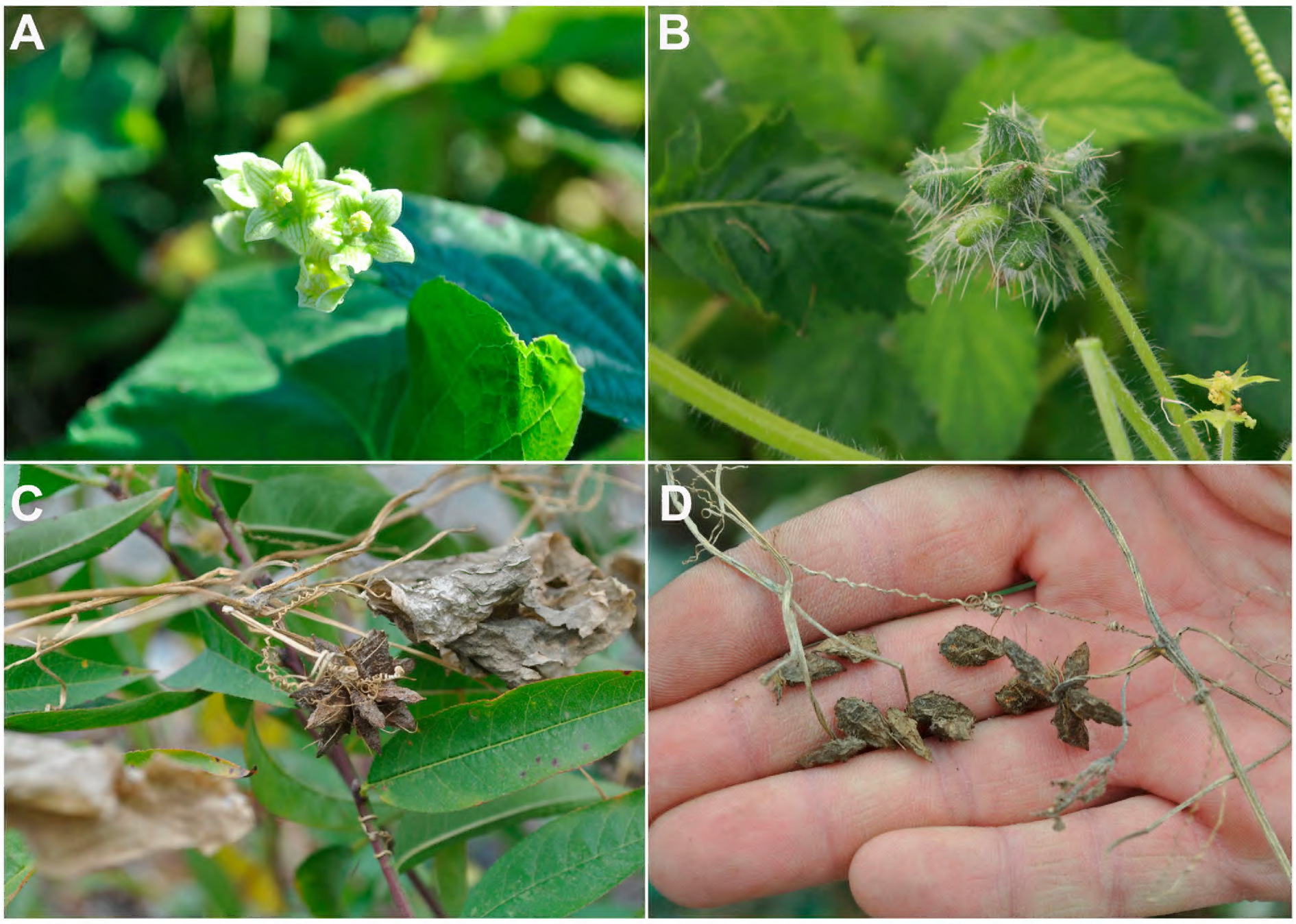

Figure 2. *Sicyos angulatus*: flowers (A), crude (B) and dry fruits and seeds (C,D). (Photos by I. Mikeladze).

Fruits are clustered, radiating from the central point, and appear as a single fruit with broad spikes. These clusters are 2.5-3.7 cm across. In fact, each 'spike' is a single fleshy fruit (a berry), dry and dehiscent at maturity, with one seed inside and a single style at the tip. Each fruit is 1.1-1.7cm long, covered with sharp, white prickles, containing a single large seed. The seed is brown, flat, tapered at one end, never fully released from the fruit. Thus, what appears to be a seed at dispersal is a single mature ovary with one seed inside.

Sicyos angulatus is an annual plant that spreads mainly by reseeding itself. Seeds are produced in large numbers: 4500-78000 seeds per plant (Esbenshade et al. 2001; Kurokawa 2023), and the enclosing fruit is disseminated by animals, which may catch the prickly fruit in their fur. In Georgia, the seeds germinate and sprout by the end of April. Seeds can germinate throughout the growing season. The vegetation period lasts to the end of October/mid-November (Fig. 2).

Three species from two genera (*Bryonia* L. and *Ecballium* A. Rich.) of the Cucurbitaceae family have been described in the Georgian natural flora (Gagnidze 2005). *Sicyos angulatus* is a recent invader for the flora of Georgia. There is no information in online databases or scientific publications about the distribution of *S. angulatus* in Georgia (Davitadze 2001; Kikodze et al. 2010; Tarkhnishvili et al. 2013; Fischer et al. 2018). In 2012, *S. angulatus* was found invading citrus plantations and homesteads in the villages near the Chorokhi River. The extent of expansion and frequency of occurrence indicate the presence of the species in the studied area before conducting our study. The assumption was verified by interviews with the local residents, who confirmed the first occurrence of the plant 10-12 years ago, initially in small numbers at riverbanks but gradually spreading to agricultural areas (Fig. 3). In 2013, a single specimen was seen on the left side of the Chorokhi River, on the territory of village Tkhilnari, in disturbed habitats and agricultural areas (41°34.423'N, 41°38.974'E) and in 2014, on the Chorokhi Delta (41°35.572'N, 41°34.728'E). In 2015, we found a few specimens around the Korolistskali (41°39.943'N, 41°40.949E) and Bartskhana rivers (41°38.993' N, 41°39.875'E). In 2015, single specimens were recorded in the lower part of Mejinistskali River (41°37.468'N, 41°36.445'E). In 2017, the plant was found in Ozurgeti, on the surrounding area of Nabzhuara River (41°55.274'N, 41°0.274'N). In 2018, it was recorded on both sides of the Sajavakho-Chokhatauri-Ozurgeti highway near the river Supsa, as well as in maize fields (41°59.247'N, 42°4.149'E; 42°0.946'N, 42°8.846'E), and in 2020, new populations were seen on the areas at the Gubazeuli River (village Nabeglavi, 41°56.899'N, 42°20.668'E). In 2021, small populations were found in Kobuleti, in the surrounding areas of the Achkva River, in agricultural plots and homesteads (41°49.349'N, 41°48.227'E). In the same year, a remarkable invasion was observed in the middle part of the Mejinistskali and Bartskhana river basins. In 2022, the plant was found on the banks of the Rioni River (42°06.294'N, 42°19.348'E).

According to field studies in the distribution area, *Sicyos angulatus* has quite large populations on moist and wet soils. The average number of individuals is 12-18 per 1 m^2. The average height is 6-8 m, although there are 12-16 m tall specimens recorded. The plant is characterized by development of numerous side shoots. Finally, the coverage

Figure 3. *Sicyos angulatus* climbing citrus shrubs on agricultural lands near river. (Photo by I. Mikeladze).

at each invaded site increases to 90-95%. It climbs over every plant encountered and hinders its development (personal observation). In agricultural croplands: maize fields and citrus plantations, it significantly reduces the qualitative and quantitative characteristics of the harvest. Another problematic property of *S. angulatus* is its spiny fruits, as they cause human skin irritation upon touch. The species expands its distribution area with each subsequent growing season. The climatic conditions of west Georgia are advantageous for the continued invasion of *S. angulatus*, which increases harm to agricultural lands and already disturbed communities, and becomes more noticeable every year.

Conclusions

Sicyos angulatus was first found in Georgia in 2012. The finding was reported on by Mikeladze et al. (2015). As the following studies, field descriptions, and collected oral materials (interviews with local residents) show, the first individual specimens of *S. angulatus* appeared on the edges of rivers in the Chorokhi Valley (Georgia) in the early 2000s.

Since 2012, the plant has spread widely on the lowlands of Kolkheti, in river valleys, in wetlands, in agricultural croplands – mainly in maize fields, in citrus plantations and homesteads. The plant adapts well to local soil and climatic conditions, grows, blooms, bears fruit, matures seeds, and expands its distribution area every year. Despite its annual life cycle, it is characterized by fast and intense growth, a climbing habit, and behaviors that make it a highly invasive species. The effect of *Sicyos angulatus* on biodiversity as well as the local economy has not been quantitatively studied. However, the species might cause significant losses and need to be further studied and monitored.

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